in the second case if bc is to be any arbitrary displacement comparable to bb' above, § 1.

If aa' are chosen cotemporaneous, since both motions are continuous, the rate at which the interval will grow from nothing at a to δt at c, dt second later is

$$\frac{d}{dt}\delta t;$$

and the distance passed along the curve in this time excess,

$$\frac{d}{dt}\delta t \cdot dt$$

is therefore

$$\dot{x}\left(\frac{d}{dt}\delta t\right)dt$$

as the figure shows. Hence obviously as before

$$\delta x + (\dot{x} + \delta\dot{x})dt + \dot{x}\frac{d}{dt}\delta t \cdot dt = \dot{x}dt + \delta x + \frac{d}{dt}\delta x \cdot dt,$$

or

$$\frac{d}{dt}\delta x = \delta\dot{x} + \dot{x}\frac{d}{dt}\delta t. \qquad (2)$$

It is also obvious that if we sum up the increments vectorially, from a to c in the two directions the same proposition will hold with regard to s;

$$\frac{d}{dt}\delta s = \delta\dot{s} + \dot{s}\frac{d}{dt}\delta t.$$

3. The important transformation

$$\frac{d}{dt}(\dot{x}\delta x) = \ddot{x}\delta x + \dot{x}\frac{d}{dt}\delta x$$

by which one passes from D'Alembert to Hamilton or to least action, respectively (see Webster's "Dynamics," which, by the way should be the text-book of every American university, patriotic or not), is a mere interpretation of the last term by the aid of equation (1) in the first case, of equation (2) in the second.

Finally with regard to variations in general it is clear that if ϕ is to have but one value at each point in space and is to vary at a single definite rate in each direction from that point, it is immaterial whether one uses the differentials, dx, dy, dz, meaning thereby that in a complete differentiation we must get back to the initial surface or region $\phi = c$; or the variations δx, δy, δz, meaning that, in general, our progress may terminate in any infinitely near region $\phi = d$, at pleasure, the same differential coefficients must be used. For along x, ϕ can not vary in any other way than at a rate, $\partial\phi/\partial x$, whether our absolute progress is to be dx or δx.

All this is simple enough, but with my students it has made the difference between the spiritless acceptation of what somebody else is supposed to understand and the satisfaction of an actual grasp of the subject.

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MOSQUITO HABITS AND MOSQUITO CONTROL

Until recently it was the general impression that all mosquitoes are blood-suckers and essentially alike in habits. Since the discovery of their relation to disease mosquitoes have been extensively studied, both systematically and biologically. While the study of mosquito biology has not by any means kept pace with the systematic work, a great deal has been learned about mosquito habits and it is now clear that there is great diversity of habits within the group.

To any one who has followed the literature, or become directly acquainted with the remarkable specializations in mosquito habits, it must be obvious that no control work can be carried out successfully and economically without intimate knowledge of the habits of these insects. Many persons, however, who are concerned with mosquitoes in a practical way, either directly in control work or as its advocates, have failed to appreciate this and hold the antiquated ideas. Work done on such a shallow basis must in many cases end in failure and disappointment.

Two striking examples, which have recently come to my notice, illustrate very well how such shortcomings lead to error. Sir Rubert W. Boyce, dean of the Liverpool School of Tropical Medicine, is the author of an interesting and excellent work which appeared recently under the title "Mosquito or Man?" While the book is written on broad lines it nevertheless contains specific statements, and

from such an author they command respect and are sure to be widely quoted. On page 96 we find this assertion:

In many of the more low-lying swampy coasts crab-holes occur in enormous numbers in the sandy soil, and in them are bred vast numbers of mosquitoes. In fact they constitute the chief nuisance in those houses which are situated near the sea.

The region in question is the tropical American littoral and the mosquitoes concerned are the species of the genus *Deinocerites* and certain species of *Culex*, all of which breed exclusively in crab-holes. I can myself testify to the abundance of these mosquitoes in their very restricted habitat, but must challenge the learned author's statement that these mosquitoes are offensive in the manner he indicates. Even where their breeding places are in close proximity to houses these mosquitoes do not enter, much less bite. Out of hundreds of specimens, collected by ourselves and received from correspondents, not one shows traces of a blood-meal, nor have we been able to observe that they are in the least attracted to human beings. On the other hand, we have female specimens of *Culex extricator*, one of the crab-hole species, in which the abdomen, distended with food, is of a pale amber color, showing that the food taken was not vertebrate blood.

Such error, however, does no harm beyond the useless expenditure entailed in the destruction of these inoffensive insects. In the case of the control of the yellow-fever mosquito a wrong assumption becomes a more serious question. The Sanitary Department of the Isthmian Canal Commission deserves great credit for its effective work in the control of this mosquito, and it is primarily the thoroughness of this work that is making possible the rapid progress in the construction of the Panama Canal. The report of the Department of Sanitation for January, 1910, gives brief data on the character of this work and the gratifying results achieved in the reduction of this mosquito.

There can be no doubt that the yellow-fever mosquito has been reduced below the danger-point within the Canal Zone, a thing made easily possible by its habits of close association with man. The implied claim, however, that this mosquito has been eradicated from certain localities within the zone can hardly be accepted upon the evidence presented. This consists of a faulty experiment based upon the erroneous idea that the yellow-fever mosquito normally lays its eggs upon the surface of the water.

At the native town in Gorgona wooden tubs with water were put under the houses on November 6, 1909, and between that time and January 6, 1910, no *Stegomyia* eggs were deposited. Had *Stegomyia* been present, eggs on the water surface would probably have been found.

The inference is that, because no larvæ appeared in the tubs and no eggs upon the surface of the water, no yellow-fever mosquitoes could be present in that locality. Such, however, is not the normal habit of oviposition of this mosquito. The eggs are deposited out of the water, at the edge of the water-film; here the eggs remain until they are submerged, when they promptly hatch. Eggs remaining out of the water retain their vitality a long time. In laboratory experiments eggs have been kept dry as long as five months and, when then submerged, produced larvæ; under favorable conditions out-of-doors it is to be supposed that they will survive even longer. Under the domestic arrangements of the more primitive tropical homes the conditions are ideal for the multiplication of this mosquito. The water receptacles in common use, which are the ordinary breeding places of this mosquito, are seldom, if ever, completely emptied; water is added from time to time, and thus whenever the water level is raised eggs can hatch. It will be readily seen that in the experiment quoted above eggs of the yellow-fever mosquito might easily have been present but could not have hatched, as the water in the tubs remained undisturbed.

FREDERICK KNAB

THE AMERICAN PHILOSOPHICAL SOCIETY

THE general meeting of the American Philosophical Society was held in the hall of the society, Independence Square, Philadelphia, on Thursday,